OBSERVATION O) ON THE RIVER FEATURES)Y MODEL

RAHAYU BINTI RAZALI

A thesis submitted in partial fulfilment of the

requirements for the award of the degree of

B.Eng (Hons.) Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2014

ABSTRACT

The process of settling of suspended material by the process of gravity is known as sedimentation. It was a natural process that carries the materials such as stones and sand that form layers of solid at the bottom of water flow. Particles are deposited when the velocity cannot supports the particles anymore, which removed from the flow with the help of gravity. The main objective why this study is carried out was to determine and observe if there was any effect of the river characteristic on the pattern of the sediments deposited. The size distribution of the sediment was also determined at every river characteristic, to prove if the river characteristic also affects the distribution of the sediments. One river model was designed with all the characteristic to be used in this study. The river model was not designed using the actual river scale because the study was only based on the river features. The experiment was run in a few sets with different sediment placement. The water flow generated the sediments and form different pattern. The pattern is then observed and captured. The samples of sediment at selected location in the river model were sieved to identify the size of sediment. Observation from the captured image of the river at studied point, shown that there are different pattern of sedimentation due to different river features. This show that the river features also affect the process of sedimentation. Sediment size distribution and flow strength are the factors that effect on sediment transport rates in the rivers. From the sieve analysis, it can be observed that the size of the sediment is different at different point of the river.

ABSTRAK

Proses penenggelaman bahan yang bergantung kepada proses graviti dikenali sebagai proses pemendapan. Ia adalah satu proses semula jadi yang membawa bahan-bahan seperti batu-batu dan pasir yang membentuk lapisan pepejal di bahagian bawah aliran air. Zarah didepositkan apabila halaju tidak lagi boleh menyokong zarah yang dibawa bersama aliran dengan bantuan graviti. Objektif utama mengapa kajian ini dijalankan adalah untuk menentukan dan membuat pemerhatian jika terdapat kesan daripada ciri sungai pada corak sedimen didepositkan. Taburan saiz sedimen yang juga diperhatikan pada setiap ciri sungai, untuk membuktikan jika ciri sungai juga memberi kesan kepada taburan sedimen. Satu model sungai telah direka dengan semua ciri yang akan digunakan dalam kajian ini. Model sungai tidak dibina dengan menggunakan skala sungai sebenar kerana kajian ini hanya berdasarkan ciri-ciri sungai. Eksperimen telah dijalankan dalam beberapa set dengan penempatan sedimen yang berbeza. Aliran air yang dihasilkan sedimen dan membentuk corak yang berbeza. Corak itu kemudiannya diperhatikan dan diambil gambar. Sampel sedimen di lokasi terpilih dalam model sungai telah disaring untuk mengenal pasti saiz sedimen. Pemerhatian daripada imej yang diambil di setiap ttik kajian menunjukkan bahawa terdapat corak pemendapan yang berbeza kerana ciri-ciri sungai yang berbeza. Ini menunjukkan bahawa ciri sungai juga memberi kesan kepada proses pemendapan. Taburan saiz sedimen dan halaju aliran air adalah antara faktor-faktor yang memberi kesan ke atas kadar pengangkutan sedimen di dalam sungai. Dari analisis ayak, ia boleh diperhatikan bahawa saiz sedimen yang berbeza pada ciri sungai yang berbeza.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

mm	millimetre
mic	Micro (mic)

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of the river. Sediment transport is critical to understanding how rivers work because it is the set of the processes that meditates between the flowing water and the channel boundary. The flow of water in the river lead to the transportation of the particles concurrently along the flow. Sediment loads are transported at the streambed by sliding, rolling and bouncing. The particles that are transported by the water in the river will be deposited and form the sediment pattern on the river bed. The sediment pattern will differ based on the different features of the river. The size distribution of the sediment also will be different.

1.1 PROBLEM STATEMENT

Sedimentation process is the process of transporting of sediment load in the river which will cause the sediments deposited with different pattern based on the river characteristic and the river landform. Variety of natural and human actions can increase the supply can also increase the supply of sand and gravel of the river. The movement of solid particles from the water flow may give effects of pollution, the land erodes, filling of reservoirs and lany other problems. Sediments will also change the dimension of the river and reduce the hydraulic capacity of the stream channel, make it shallower.This may cause an increase in floods occurrence and flood damage. Besides that, the sediments also affect the habitat diversity in sediments and stream. If the sediments are not managed

effectively, it may lead to giving bad effects to many lives. However, it is a bit difficult to study about sedimentary in nature because there are too many outside factors that may affect the results. This factor leads to the problems to measure the travel rates accurately during the flow condition. Laboratory experiments are the choice because all the variables can be controlled.

1.2 OBJECTIVES

The objectives of this study are as follows:

1. To determine the pattern of sedimentation on the river based on the river characteristic.

2. To determine the size distribution of sediment at different point of the river.

1.3 SCOPE OF STUDY

The scopes of this study are as follows:

1. The study is done based on the river model that is built up with concrete.

2. The river model was not using the scale of the actual river.

3. The velocity used for every flow is 35 m/s.

4. The pattern is observed based on different river characteristic:

   i. Different angle of river slope

   ii. Presence of obstruction in the middle of the flow.

   iii. There are water flows from the tributary entering the main river.

   iv. Shape of the river: straight, meandering and wide rivers

5. Sediment at every point will be collected and sieved to determine the size distribution of the sediment.

1.4 EXPECTED OUTCOMES

By doing studies and research on the river, a river model can be created with all the features that is going to be studied. From the river model, the pattern of the river will be different based on the features of the river. This is because the different features of the river give effect to the flow and at the same time it will affect the pattern of the sediments.

The distribution of the sediments will also differ based on the different river features and the point where the sediment is collected. This is because the size of the sediments also affects the transportation of the sediments. The smaller size of sediments will be easily transported together with the water flow.

1.5 SIGNIFICANCE OF STUDY

In the real world, it is not easy to find a river that has all the river features or if the river like that exist, the distance may be too long and it is so hard to be studied. From the river model that was built with a few features that exist in almost river, it will help to determine the pattern of sediments from the observation. So, there's no need to go to the actual river and it will be easier, especially for the students to study just from the model. It means that the river model can be used for education in class. This section will provide a brief description on the various significances of the study given the three categories Educational, Technological and Economic. The purpose of this experiment is to document the effect of the characteristic of the river on the sedimentation process.

2.2.1 Wash load

The finest particles that are transported by the water and do not exist on the river bed. Therefore the wash load transport does not affect the bed materials. Wash load do not always related to the parameters of the river flow. However, there's a possibility of the wash load in the upstream channel to become a bed - material load on downstream.

Wash load is very fine particles which are transported by water, but these particles do not exist on the bed. Therefore the knowledge of bed material composition does not permit any prediction of wash load transport (Liu, 2001).

Wash load is the finest-grained fraction of the total riverine sediment load and accounts of roughly 70 percent of sediment delivered to our world's oceans (Knighton, 1998).

Although wash load is part of the suspended-sediment load it is useful here to make a distinction. Unlike most suspended-sediment load, wash load does not rely on the force of mechanical turbulence generated by flowing water to keep it in suspension. Because these clays are always in suspension, wash load is that component of the particulate or clastic load that is "washed" through the river system (Hickin, 1998).

2.2.2 Bed load

The part of total load that has continuous contact with the bed. These heavier particles are usually sands and gravels. Bed load is transported close to the bottom and moves at a slower rate than the water flow. There are various motion for the bed load in the river, which is rolling motion, sliding motion and saltation motion. Saltation motion is the motion of sediment particles in a series of irregular jumps and bounces around the bed. But, it can be suspended load under rapid flow. This is because bed load dominates for low flows or large grains.

Bed load is defined as "the sediment in almost continuous contact with the bed, carried forward by rolling, sliding or hopping" (ISO772, 1996).

Bed load is the part of the total load which has more or less continuous contact with the bed. Thus, the load must be determined in relation to the effective shear stress, which act directly on the grain surface (Liu, 2001).

Bed load transport, which results from the motion of particles rolling, sliding or travelling in a succession of low jumps or saltation along the bed of a stream, is about the fundamental importance of morphodynamics (Métivier, 2004).

Traditionally, the transport of sediment, especially bed load was simulated based on the assumption of local or instantaneous equilibrium (Thomas, 1982).

2.2.3 Suspended load

The part of total load that has not had continuous contact with the bed. It moves through the fluid. Suspended load consists of generally finer, smaller particles than bed load. Turbulent flow suspends clay and silt in the stream. The finer-grained suspended load can be found far from the bottom and being transported at lower concentrations but at a much higher rate.

Suspended load is the total load which is moving without continuous contact with the bed as a result of the agitation of the fluid turbulence. The appearance of ripples will increase the bed shear stress (flow resistance). On the other hand, more grains will be suspended due to the flow separation on the lee side (Liu, 2001).

Suspended-sediment load is the clastic (particulate) material that moves through the channel in the water column. These materials, mainly silt and sand, are kept in suspension by the upward flux of turbulence generated at the bed of the channel (Hickin, 1998).

2.3 CHARACTERISTIC OF THE RIVER

Along the path of a river, from source to mouth, the river shows many different features and is affected by several different processes.

2.3.1 Slope of the river

The gradient of the river bed is the ratio of the horizontal and vertical fall over the river. The changes in gradient will affect the discharge. The discharge will decrease as the gradient increase, means that the river that has the steep slope and higher diagram has the higher velocity.

For channels with steep slopes, there are the effect of gravity on the sediment transport exist (Sekine, 1992).

The depth of the water decrease as the slope steepens. The slope of the river usually stays virtually constant. Steeper slope results in faster moving runoff, which results in greater erosion (Kamber, 1990).

2.3.2 Presence of obstruction

The two most important forces controlling water movement in obstruction are gravity and molecular attraction. Gravity causes the water to infiltrate until it reaches impermeable zones where it is diverted laterally. Gravity generates the flow of springs, rivers, and wells. If the pores in rocks and sediments are connected, gravity allows the water to move slowly through them. However, the smaller the opening, the harder it is for gravity to cause water movement. The second force, molecular attraction, slows the flow of water through small pores. Water is attracted to the surface of every particle with which it comes in contact. The force results from the attraction of the molecules of two substances for each other. The attraction between water and soil or rock particles is termed adhesion. It is effective only over short distances. Thus, only a thin film of water is locked to the outside of each grain resisting the flow downward in response to gravity (McCray, 2010).

2.3.3 Tributaries and confluence

The tributaries are the branch of the river. The water from the tributaries will enter the mainstream, which will flow to the river. The source of the tributary is usually from

the high ground. The tributary will flow the water and bring the sediments together into the main river.

A tributary is a stream that flows into a larger stream or other body of water (South shore estuary reserve council).

Confluence is formed when the tributary combined with the main river to form hydraulic singularity that converge in a single channel downstream. The analysis reveals that a local tributary widening in the confluence zone creates a zone of an important variety of flow depths, bed constitution and flow velocities without adverse effects on the conveyance capacity.

2.3.4 Shape of river

The shape of the river may change due to the water that flows continuously. The shape of the river occurs because of three processes, that is; erosion, transportation and deposition.

The process of erosion is divided into three parts that is hydraulic action, abrasion, attrition and the solution. Hydraulic action is the sheer force of water hitting the banks of the river. Abrasion is fine material rubs against the riverbank. The bank is worn away by a sand-papering action called abrasion, and collapses. This occurs on the outside of meanders. Attrition is material is moved along the bed of a river, collides with other material, and breaks up into smaller pieces. The solution is rocks forming the banks and bed of a river are dissolved by acids in the water.

Process of transportation was divided into traction, saltation, suspension and solution. Traction occurs when large rocks and boulders roll along the bed of the river. Saltation is occurred when smaller stones are bounced along the bed of the river. Suspension is the fine material which is carried by the water and which gives the river its 'muddy' colour, while solution is dissolved material transported by the river.

Deposition occurs when the river dumps its load and is related to the energy of the river; the largest first and then progressively smaller. The fine clay particles only settle when the velocity is zero.

The size and shape of the channel changes as the river lows downstream. All the process explained above cause the change in the river shape.

(i) Straight river

It is one of the typical river patterns in terms of channel plain landform. But, there are not many straight patterns river were found to be distributed in the river with a wider span in the fluvial river. The straight river only has a single straight channel. Straight channel has some stability and its plan form may change or disappear during the channel migration.

Straight river is generally regarded as one of the typical river patterns in conventional classifications in terms of their channel plain landforms. However, a few straight patterns were found to be distributed in wider spatial and temporal spans in the self-fluvial river (WANG Sui-ji, 2002).

(ii) Meander River

Meander River is an extreme U-bend river in the course of a stream. They are usually formed in the alluvial materials so it can freely adjust the shapes and shift downstream according to the slope of the alluvial valley.

Meandering rivers have a low gradient and thus slower flow, and often have a high proportion of suspended sediment relative to the amount of bed load. A meandering river channel has curves that meander back and forth on a slightly dipping plain (Dawn Summer, 2008).

(iii) Wide river

For the wide river, the water flow can be thought of as being in horizontal "sheets", so all the water at the same depth is moving at the same velocity. For a river flowing steadily down a gentle incline under gravity, we'll assume all the streamlines point in the same direction, the river is wide and of uniform depth, and the depth is much smaller than the width (Fowler, 2012).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The experiments on this topic will be conducted based on the river model that is made up of concrete. The river will be build based on the study and research on the river features to determine the sedimentation pattern.

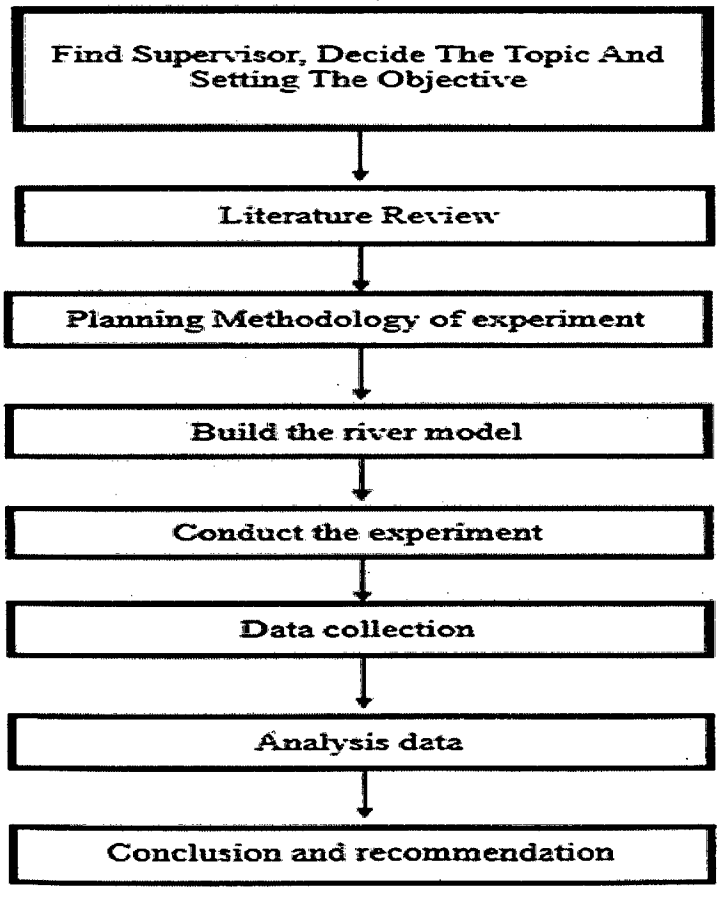

Figure 3.1: Flowchart of the methodology

3.2 RIVER MODEL

The experiments on this topic will be conducted based on the river model that is made up of concrete. The river model was constructed put in a wooden box. The wooden box is filled with soil and is compact and shaped as a river.

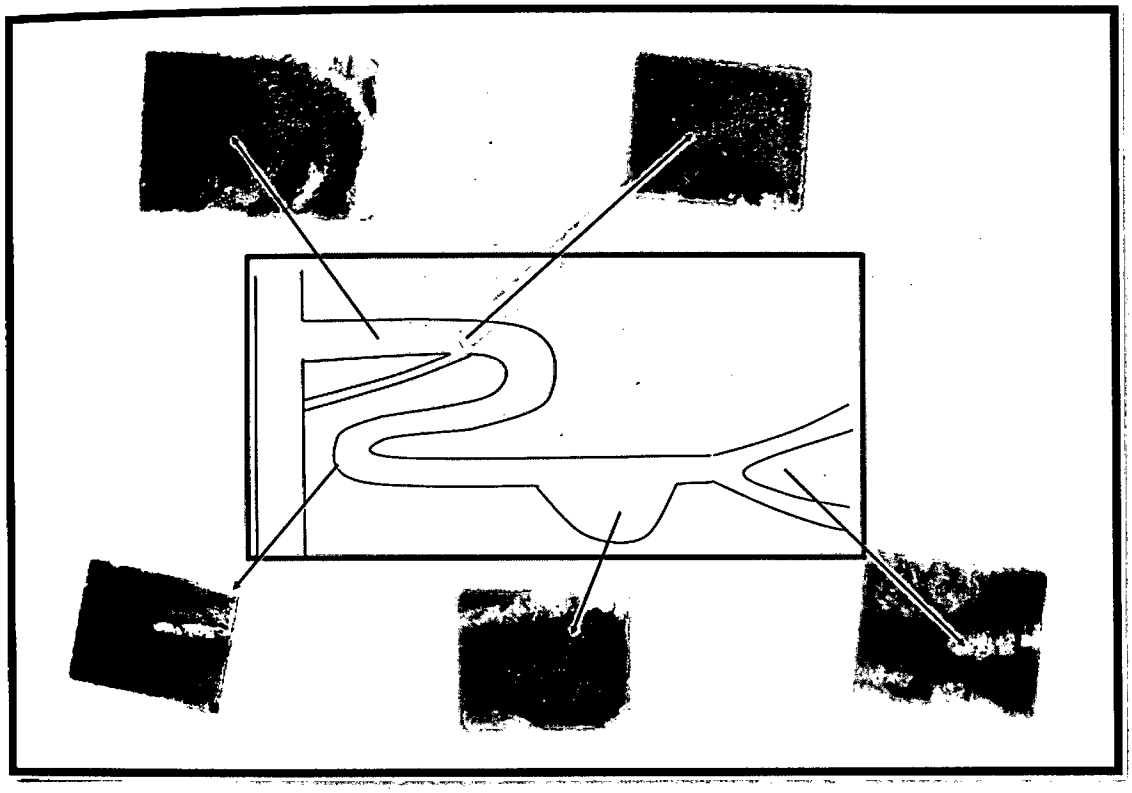

Figure 3. 2: River features

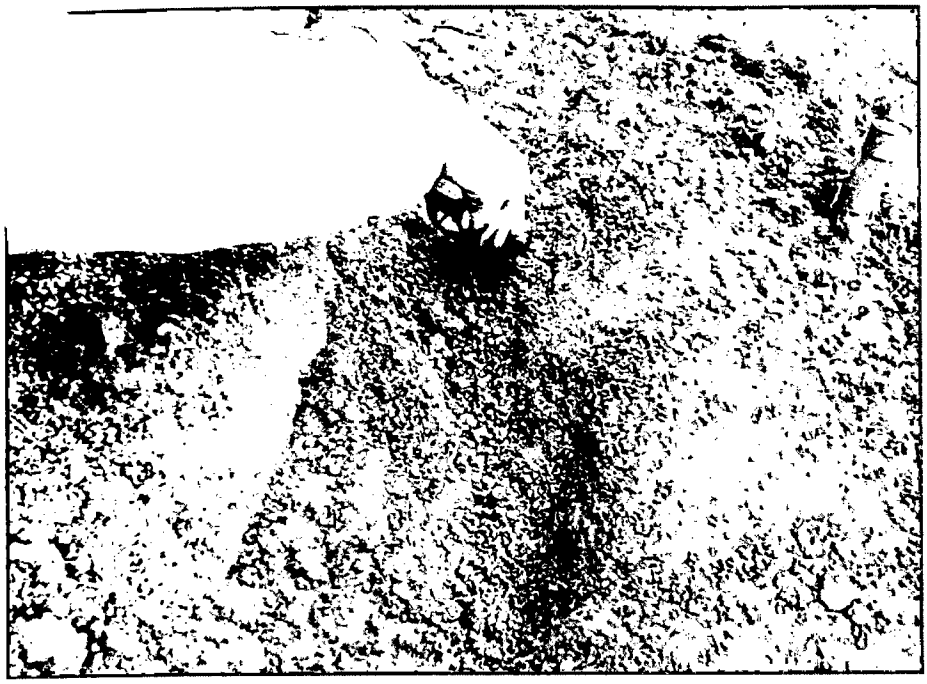

Figure 3.3: Removing the soil to shape the river

Figure 3.4: Shaping the model

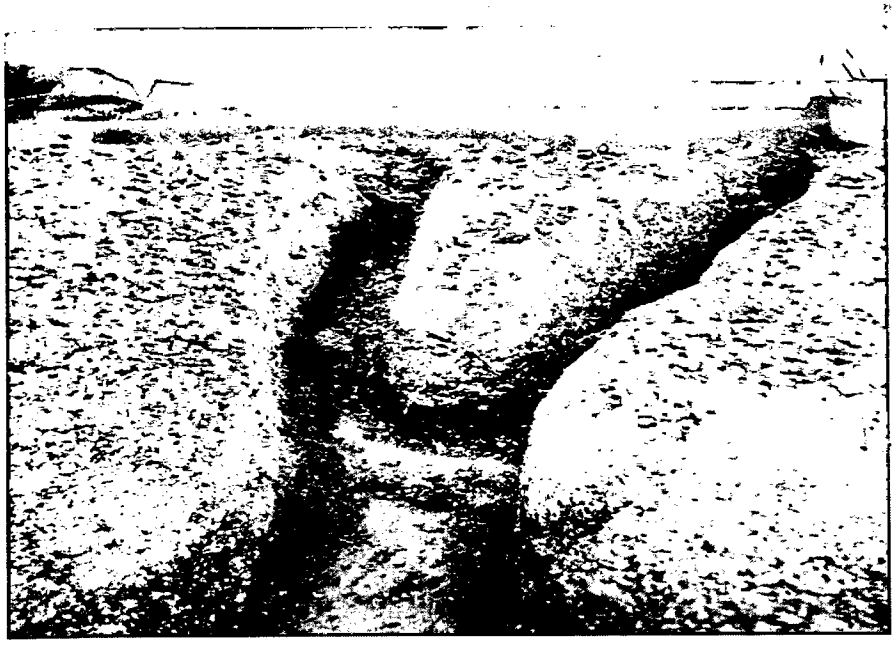

Figure 3.5: River shape for the slope

Then, the river part will be overlaid with the concrete to make sure the water will not penetrate.

Figure 3 6: Layered the river model with cement

Figure 3.7: Touch up the river model

The river will be built to fulfil all the following features:

1. Shape of the river
2. The presence of obstruction
3. Tributaries and confluence
4. River gradient /slope angle

Figure 3.8: Straight river

Figure 3.9: Meander river

Figure 3.10: Wide river